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(54) **MAGNETIC SWITCH ACTUATORS**

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(51) **Int. Cl.**

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H01H 36/00 (2006.01)

H03K 17/97 (2006.01)

H01H 3/16 (2006.01)

(57)

ABSTRACT

Magnetic switches are disclosed herein. An example apparatus includes a mount and a switch actuator assembly coupled to the mount. The switch actuator assembly includes a body, a trigger, and a first magnet oriented to be attracted to a second magnet. Movement of the body from a first position to a second position is to cause relative movement between the first magnet and the second magnet and relative movement between the trigger and a switch.

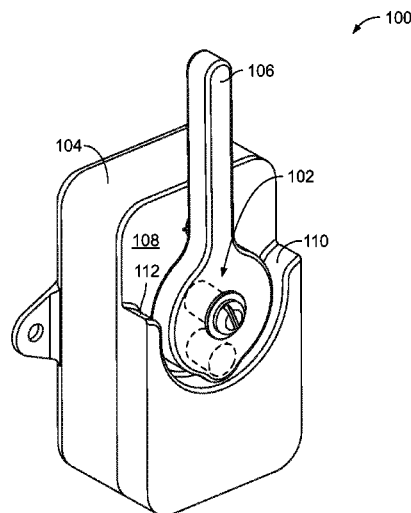
(52) **U.S. Cl.**

CPC **H01H 36/0073** (2013.01); **H01H 36/00**
(2013.01); **H03K 17/97** (2013.01); **H01H 3/16**
(2013.01)

(58) **Field of Classification Search**

CPC H01H 36/00; H01H 3/16; H01H 36/0073;
H01H 36/008; H03K 17/97

20 Claims, 6 Drawing Sheets



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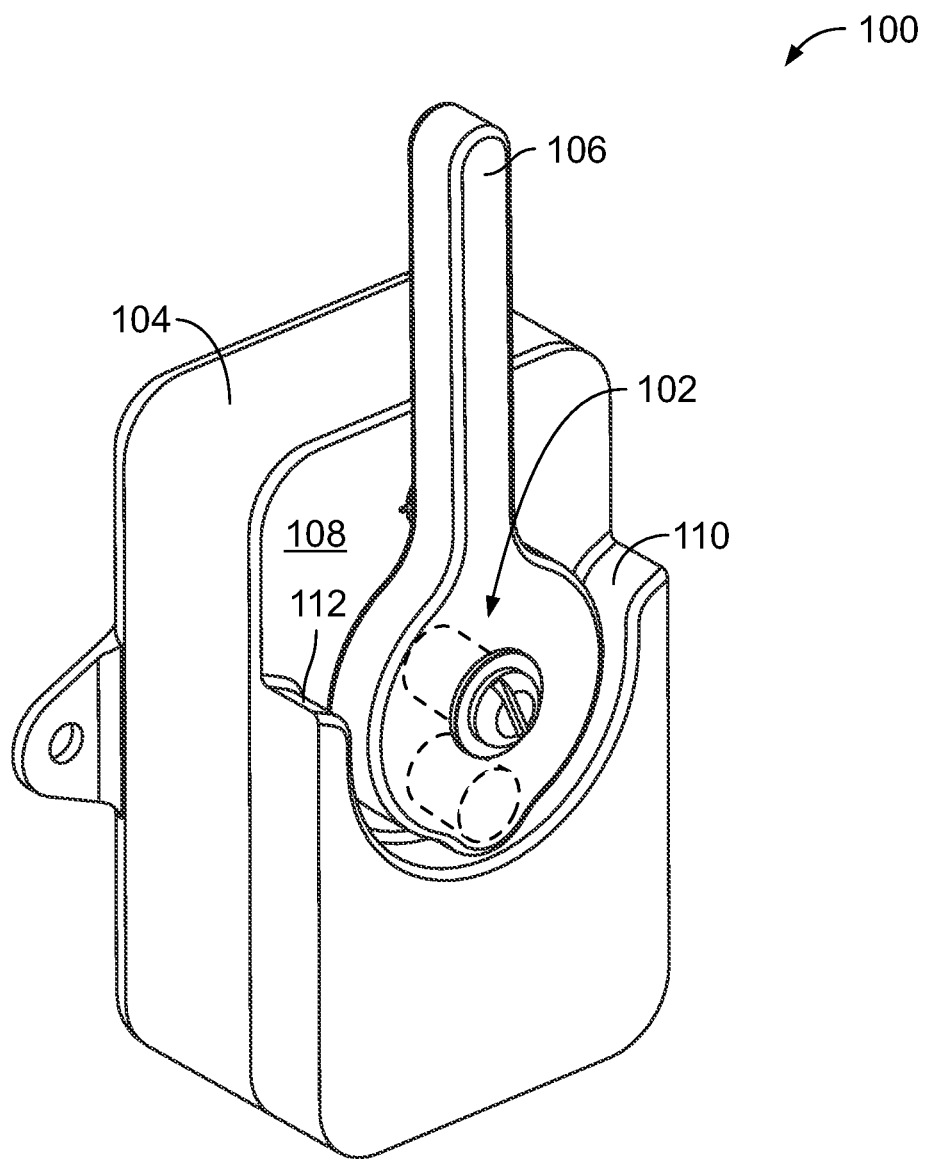


FIG. 1

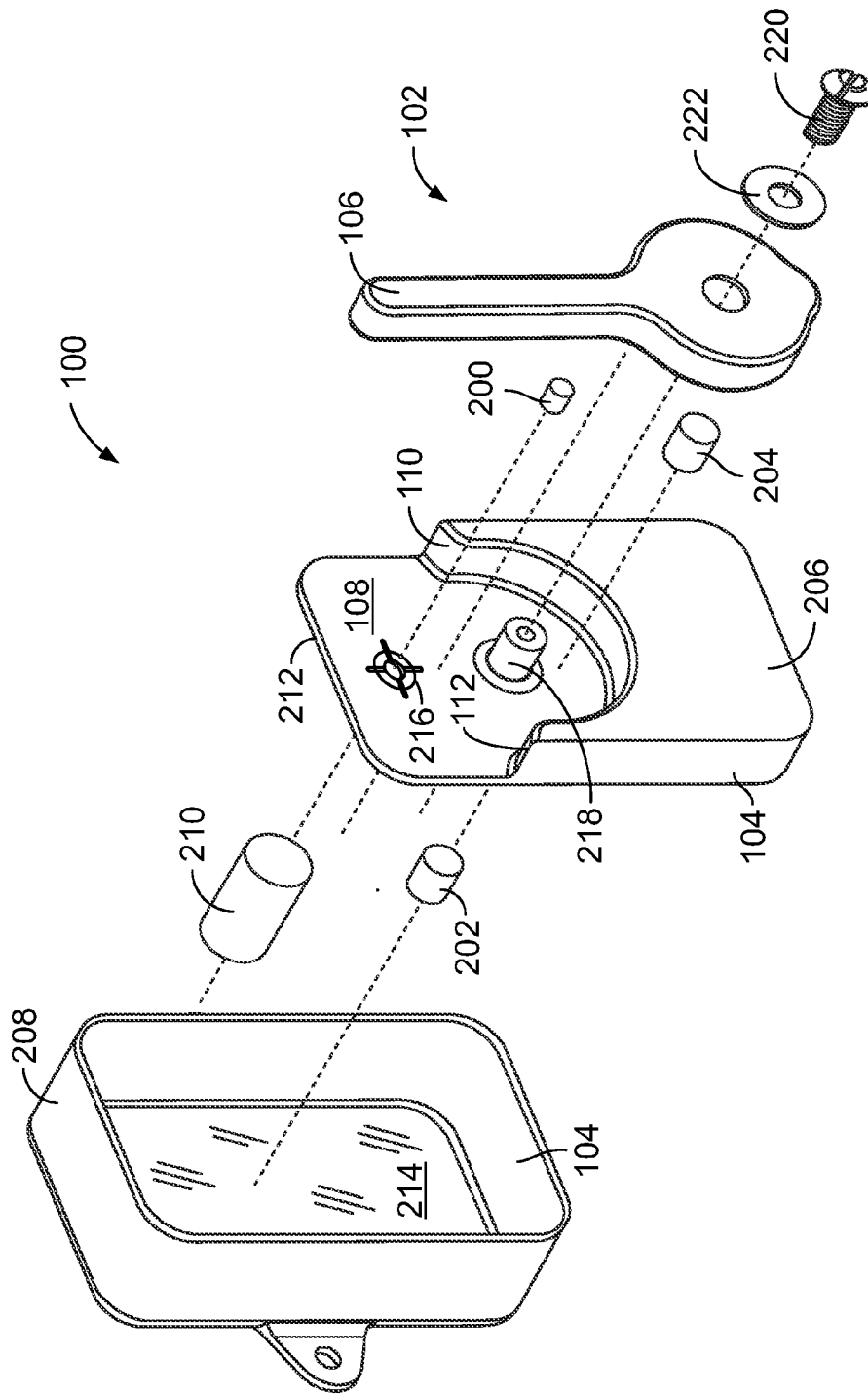


FIG. 2

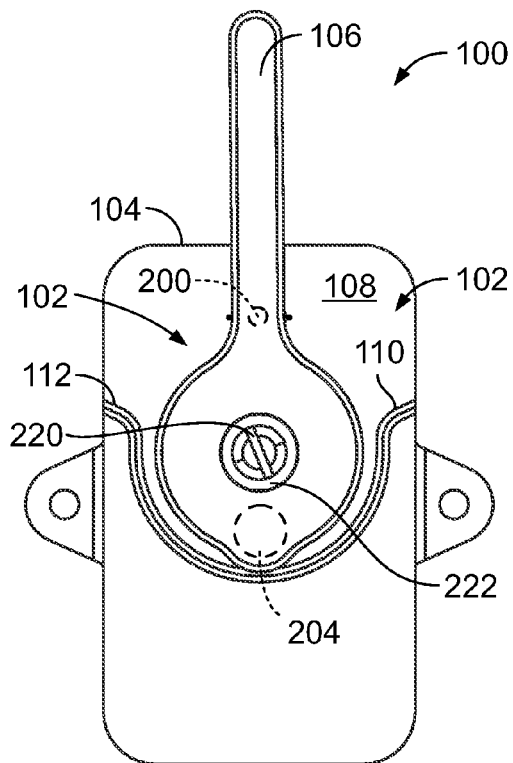


FIG. 3

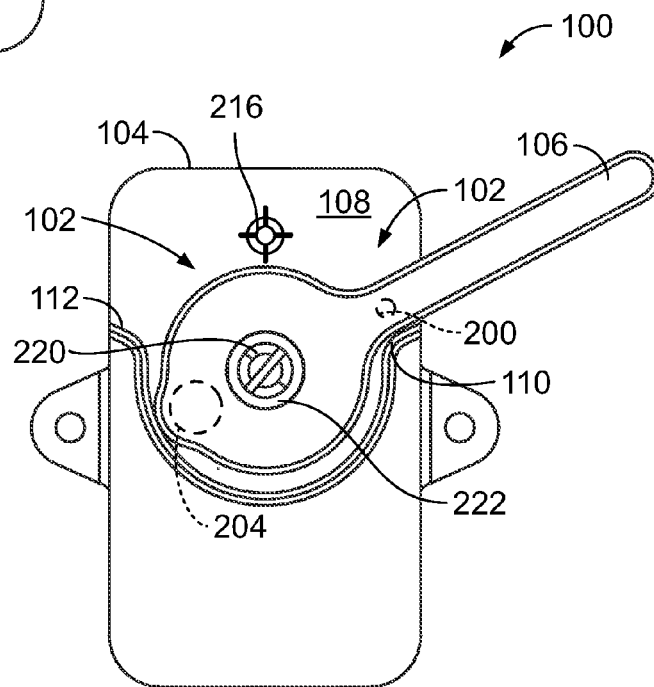


FIG. 4

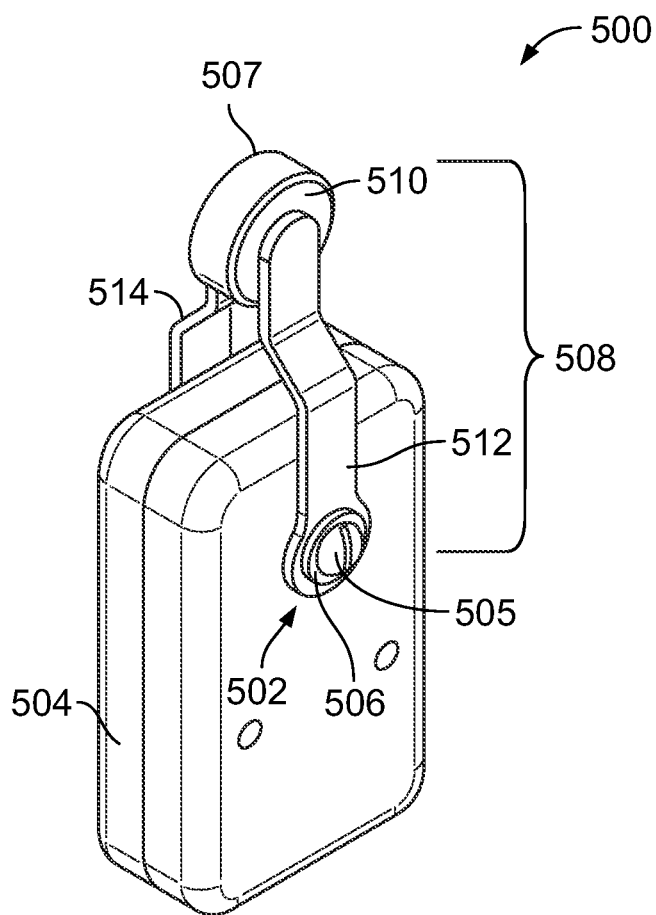


FIG. 5

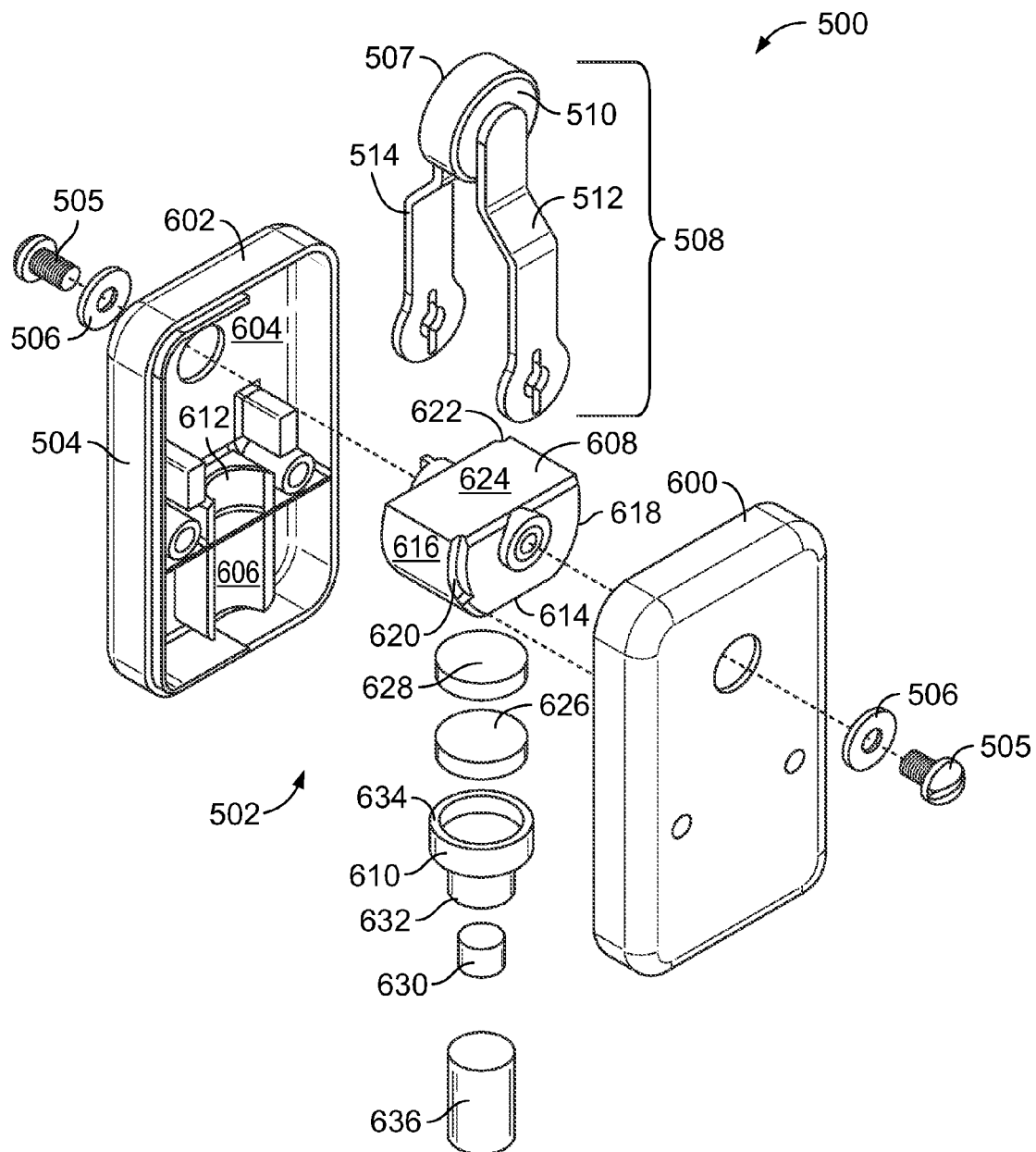


FIG. 6

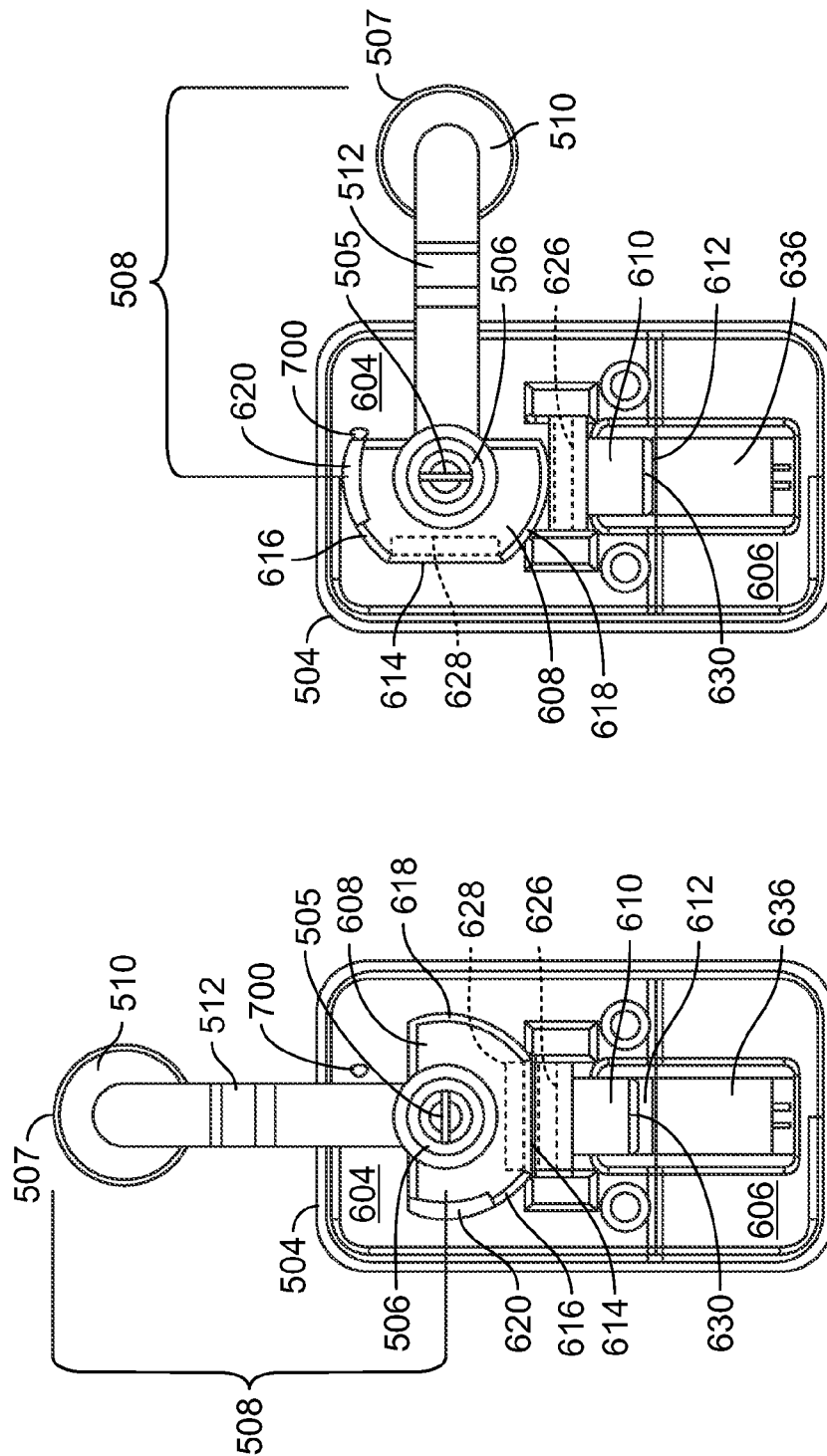


FIG. 7

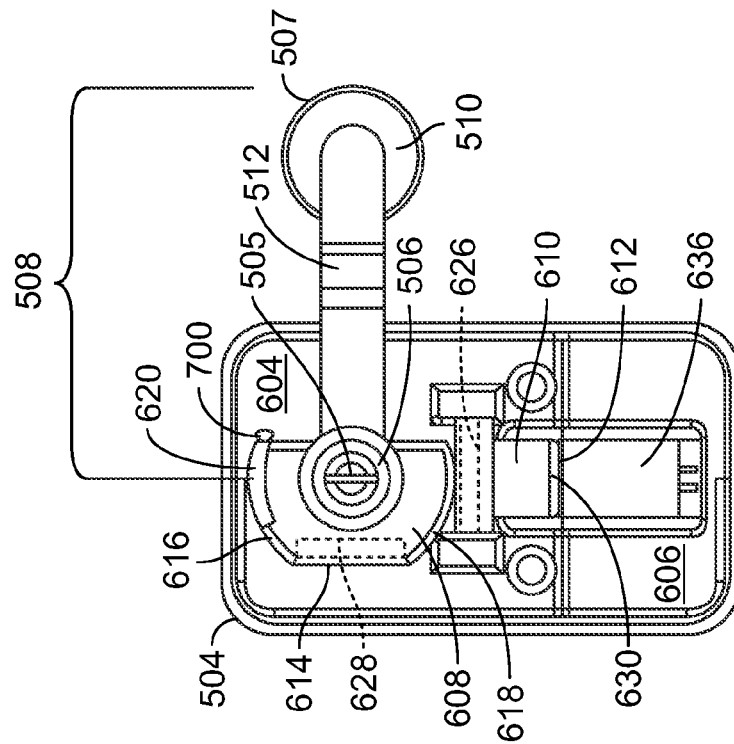


FIG. 8

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MAGNETIC SWITCH ACTUATORS

RELATED APPLICATIONS

This patent claims priority from Chinese Patent Application Serial Number 201220222096.2, entitled "Magnetic Switch Actuators," which was filed on May 14, 2012, and is hereby incorporated by reference in its entirety.

FIELD OF THE DISCLOSURE

This disclosure relates generally to switches and, more particularly, to magnetic switch actuators.

BACKGROUND

A switch often includes an actuator such as a button or a lever. Typically, a portion of the actuator is conductive. When the actuator is moved from a first position to a second position, the conductive portion of the actuator generally engages (i.e., closes) or disengages (i.e., opens) one or more sets of electrical contacts. In some switches, a spring moves the actuator back to the first position to reset the switch.

SUMMARY

An example apparatus includes a mount including a first magnet and a body movably coupled to the mount. The body includes a second magnet. The example apparatus also includes a trigger movable with the body. The first magnet and the second magnet urge the body toward a first position, and movement of the body from the first position to a second position is to cause the trigger to actuate a switch via a magnetic field.

Another example apparatus includes a mount and a switch actuator assembly coupled to the mount. The switch actuator assembly includes a body, a trigger, and a first magnet oriented to be attracted to a second magnet. Movement of the body from a first position to a second position is to cause relative movement between the first magnet and the second magnet and relative movement between the trigger and a switch.

Another example apparatus includes means for actuating movably coupled to means for mounting the means for actuating. The means for mounting includes first means for magnetically urging the means for actuating, and the means for actuating includes second means for magnetically urging the means for actuating. The example apparatus also includes means for magnetically actuating a switch movable with the means for actuating. The first means for magnetically urging and the second means for magnetically urging urge the means for actuating toward a first position, and movement of the means for actuating from the first position to a second position is to cause the means for magnetically actuating the switch to actuate the switch via a magnetic field.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an example apparatus disclosed herein.

FIG. 2 depicts an exploded view of the example apparatus of FIG. 1.

FIG. 3 illustrates the example apparatus of FIG. 1 in a first position.

FIG. 4 illustrates the example apparatus of FIG. 1 in a second position.

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FIG. 5 illustrates another example apparatus disclosed herein.

FIG. 6 depicts an exploded view of the example apparatus of FIG. 5.

FIG. 7 illustrates the example apparatus of FIG. 5 in a first position.

FIG. 8 illustrates the example apparatus of FIG. 5 in a second position.

DETAILED DESCRIPTION

A switch often includes a switch actuator (e.g., a button, a lever, etc.) coupled to a spring. A portion of the switch actuator may be conductive. When the switch actuator is moved from a first position to a second position, the conductive portion may engage (i.e., close) one or more sets of electrical contacts or disengage (i.e., open) the one or more sets of electrical contacts, thereby actuating the switch. The spring may then reset the switch by moving the switch actuator back to the first position. However, the spring may fatigue and fail. Also, the switch may be subjected to corrosive conditions. As a result, the contacts may corrode and/or oxidize, thereby causing the switch to fail.

Example apparatus disclosed herein may be used to actuate a switch via a magnetic field without mechanically contacting the switch. The example apparatus disclosed herein may physically partition or separate a switch actuator assembly from the switch, thereby enabling the switch to be segregated or isolated from a corrosive environment to which the switch actuator assembly may be exposed. The example apparatus disclosed herein include a mount including a first magnet and a body movably coupled to the mount. The body includes a second magnet. The example apparatus also include a trigger movable with the body. In some examples, the body is a lever and a cam, and the trigger is movable with the body via a follower adjacent the cam. In other examples, the body is elongated and the trigger is disposed along a length of the body. The first magnet and the second magnet urge the body toward a first position, and movement of the body from the first position to a second position is to cause the trigger to actuate the switch via a magnetic field. The movement of the body from the first position to the second position is to cause relative movement between the first magnet and the second magnet and relative movement between the trigger and the switch. In some examples, the mount partitions the body from the switch.

FIG. 1 illustrates an example apparatus 100 disclosed herein. The example apparatus 100 includes a switch actuator assembly 102 coupled to a mount 104. The switch actuator assembly 102 includes a body 106. In the illustrated example, the body 106 is elongated, and the body 106 is rotatably coupled to an exterior face 108 of the mount 104. In some examples, the body 106 is slidably coupled to the exterior face 108 of the mount 104. The example mount 104 illustrated in FIG. 1 includes protrusions or stop surfaces 110 and 112 adjacent the body 106 to limit movement of the body 106.

In the illustrated example of FIG. 1, the body 106 is in a first position. The body 106 is movable from the first position in a first direction or a second direction opposite the first direction. The mount 104 and the body 106 are non-magnetic (e.g., plastic, ceramic, etc.). As described in greater detail below in connection with FIG. 2, when the body 106 moves from the first position to a second position, a trigger 200 actuates a switch 210 via a magnetic field.

FIG. 2 depicts an exploded view of the example apparatus 100 of FIG. 1. The example switch actuator assembly 102

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also includes the trigger **200**, a first magnet **202** (e.g., a samarium-cobalt magnet, a neodymium magnet, etc.), and a second magnet **204** (e.g., a samarium-cobalt magnet, a neodymium magnet, etc.). In the illustrated example, the mount **104** includes a cover **206** and a base **208** to enclose the first magnet **202** and the switch **210** (e.g., a TopWorx GO® Switch, an inductive proximity switch, etc.). The first magnet **202** and the switch **210** are coupled to an interior surface **212** of the cover **206** and/or an interior surface **214** of base **208**. Thus, the mount **104** partitions (e.g., physically isolates or separates) the body **106** from the switch **210**. In some examples, the switch **210** includes a proximity sensor. In the illustrated example, the exterior face **108** of the cover **206** includes a visual indicator **216** adjacent the switch **210**. Also, the body **106** is mounted on a fulcrum or pivot **218** extending from the exterior face **108** of the cover **206**. The body **106** is fastened or secured to the fulcrum or pivot **218** via, for example, a screw **220** and a washer **222**. In some examples, the cover **206** and the base **208** are hermetically sealed to isolate the switch **210** from an ambient environment surrounding the example apparatus **100** and, thus, the actuator assembly **102**.

The body **106** includes the second magnet **204** and the trigger **200**. The trigger **200** is magnetic and/or ferrous. The second magnet **204** and the trigger **200** are disposed along a length of the body **106**. In some examples, the trigger **200** and/or the second magnet **204** are coupled to an exterior surface of the body **106**. In other examples, the trigger **200** and/or the second magnet **204** are disposed inside the body **106**. In the illustrated example, the trigger **200** and the second magnet **204** are disposed in recesses (not shown) of the body **106**.

FIG. 3 illustrates the body **106** of the switch actuator assembly **102** in the first position. In the illustrated example, when the body **106** is in the first position, the switch **210** and the trigger **200** are substantially aligned and the first magnet **202** and the second magnet **204** are substantially aligned. The first magnet **202** is oriented to be attracted to the second magnet **204** (e.g., a north pole of the first magnet **202** is adjacent the cover **206** and a south pole of the second magnet **204** is adjacent the cover). Thus, the first magnet **202** and the second magnet **204** urge the body **106** toward the first position.

In the illustrated example, when the body **106** is in the first position, the trigger **200** causes the switch **210** to be in an open state or a closed state via a magnetic field provided by the trigger **200** and/or the switch **210**. In some examples, the switch **210** and the trigger **200** are not substantially aligned when the body **106** is in the first position, and the trigger **200** does not cause the switch **210** to be in an open state or a closed state when the body **106** is in the first position.

FIG. 4 illustrates the body **106** in the second position. Movement of the body **106** causes relative movement between the trigger **200** and the switch **210**. The body **106** may rotate in the first direction or the second direction opposite the first direction. When the body **106** moves from the first position to the second position, the trigger **200** moves with the body **106** away from the switch **210**, thereby causing the trigger **200** to actuate the switch **210** to the open state or the closed state via movement of the magnet field provided by the trigger **200** and/or the switch **210**. In some examples, the movement of the body **106** toward the second position moves the trigger **200** toward the switch **210**,

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thereby causing the trigger **200** to actuate the switch **210** via movement of the magnetic field provided by the trigger **200**.

The movement of the body **106** also causes relative movement between the first magnet **202** and the second magnet **204**. When the body **106** rotates from the first position to the second position, the second magnet **204** moves away from the first magnet **202**. The magnetic fields of the first magnet **202** and the second magnet **204** urge the second magnet **204** toward the first magnet **202** and, thus, urge the body **106** toward the first position. As a result, after a user moves the body **106** from the first position to the second position and releases the body **106**, the body **106** moves back to the first position and the switch **210** resets.

FIG. 5 illustrates another example apparatus **500** disclosed herein. The example apparatus **500** includes a switch actuator assembly **502** coupled to a mount **504** via, for example, screws **505** and washers **506**. In the illustrated example, the switch actuator assembly **502** includes a body **507** pivotably coupled to the mount **504**. The body **507** includes a lever **508** and a cam **608** (FIG. 6). The example lever **508** includes a handle **510** (e.g., a knob, grip, roller, etc.) coupled to a pair of brackets **512** and **514**. The brackets **512** and **514** are pivotably coupled to opposing sides of the mount **504**.

In the illustrated example, the body **507** is in a first position. The body **507** is movable from the first position in a first direction or a second direction opposite the first direction. The mount **504** is nonmagnetic (e.g., plastic, ceramic, etc.). As described in greater detail below, when the body **507** moves from the first position to a second position, a trigger **630** (FIG. 6) actuates a switch **636** (FIG. 6) via a magnetic field.

FIG. 6 depicts an exploded view of the example apparatus **500** of FIG. 5. In the illustrated example, the mount **504** includes a first cover **600** and a second cover **602**. In some examples, the first cover **600** and the second cover **602** are joined via a hermetic seal. The covers **600** and **602** define a first chamber **604** and a second chamber **606**.

The cam **608** of the body **507** is disposed in the first chamber **604** and coupled to the brackets **512** and **514** of the lever **508** via the screws **505**. A follower **610** is adjacent the cam **608**. The follower **610** is movably coupled to the mount **504** via a slot or bore **612** in the first chamber **604**. In the illustrated example, the cam **608** includes a substantially planar face **614** adjacent the follower **610** and curved faces **616** and **618** extending outwardly from the planar face **614** to define a path of the follower **610**. However, the above-noted shape of the cam **608** is merely an example and, thus, other shapes may be used without departing from the scope of this disclosure.

The cam **608** includes corner grooves **620** and **622** that extend from a top face **624** of the cam **608** toward the planar face **614** of the cam **608** in the orientation of FIG. 6. The grooves **620** and **622** do not extend through the planar face **614** of the cam **608**. As described in greater detail below, the grooves **620** and **622** are to receive a protrusion **700** (FIG. 7) when the cam **608** rotates to limit movement of the body **507**.

The example switch actuator assembly **502** also includes a first magnet **626** (e.g., a samarium-cobalt magnet, a neodymium magnet, etc.), a second magnet **628** (e.g., a samarium-cobalt magnet, a neodymium magnet, etc.) and the trigger **630**. The second magnet **628** is coupled to the cam **608**. In some examples, the second magnet **628** is disposed on the planar face **614** of the cam **608**. In other examples, the second magnet **628** is disposed inside the cam

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608. The first magnet 626 is coupled to an end 634 of the follower 610 adjacent the cam 608. The first magnet 626 is oriented to be attracted to the second magnet 628 (e.g., a north pole of the first magnet 626 is adjacent a south pole of the second magnet 628). As a result, the cam 608 and the follower 610 are operatively coupled via magnetic fields of the first magnet 626 and the second magnet 628. The trigger 630 is also coupled to the follower 610. The trigger 630 is disposed on an end 632 of the follower 610 adjacent the second chamber 606. The trigger 630 is magnetic and/or ferrous.

The mount 504 partitions the switch 636 (e.g., a TopWorx GO® Switch, an inductive proximity switch, etc.) from the body 507. In the illustrated example, the switch 636 is enclosed in the second chamber 606 to partition or isolate the body 507 from the switch 636. The switch 636 includes a proximity sensor. As described in greater detail below, movement of the body 507 causes the trigger 630 to actuate the switch 636 via a magnetic field.

FIG. 7 illustrates the example apparatus 500 of FIG. 5 in the first position. When the body 507 is in the first position, the first magnet 626 and the second magnet 628 are substantially aligned, and the follower 610 abuts the planar face 614 of the cam 608. The first and second covers 600 and 602 each include a protrusion 700 disposed in the first chamber 604 to be received in one of the slots 620 and 622 of the cam 608 to limit the movement of the body 507.

FIG. 8 illustrates the example apparatus 500 of FIG. 5 in the second position. The trigger 630 is movable with the body 507 via the follower 610, and movement of the body 507 causes relative movement between the trigger 630 and the switch 636. The body 507 may rotate in the first direction or the second direction from the first position. In the illustrated example, movement of the body 507 from the first position causes the cam 608 to rotate. The magnetic fields of the first magnet 626 and the second magnet 628 cause the follower 610 to remain in contact with the cam 608 such that when the cam 608 rotates from the first position, one of the curved surfaces 616 and 618 of the cam 608 moves the follower 610 downward in the slot 612 in the orientation of FIG. 8 and, thus, moves the trigger 630 toward the switch 636. As a result, the trigger 630 actuates the switch 636 without contacting the switch 636 via a magnetic field provided by the trigger 630 and/or the switch 636.

Movement of the body 507 also causes relative movement between the first magnet 626 and the second magnet 628. When the body 507 rotates from the first position to the second position, the second magnet 628 rotates away from the first magnet 626. The magnetic fields of the first magnet 626 and the second magnet 628 urge the second magnet 628 toward the first magnet 626 and, thus, urge the body 507 toward the first position. As a result, after a user moves the body 507 from the first position to the second position and releases the body 507, the body 507 moves back to the first position via the magnetic fields, thereby moving the follower 610 upward in the orientation of FIG. 8 and causing the switch 636 to reset.

Although certain example methods and apparatus have been described herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all methods, apparatus and articles of manufacture fairly falling within the scope of the appended claims either literally or under the doctrine of equivalents.

The Abstract at the end of this disclosure is provided to comply with 37 C.F.R. §1.72(b) to allow the reader to quickly ascertain the nature of the technical disclosure. It is

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submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.

What is claimed is:

1. An apparatus, comprising:
 - a mount including a first magnet;
 - a body movably coupled to the mount, the body including a second magnet; and
 - a trigger movable with the body, wherein the first magnet and the second magnet urge the body toward a position, and wherein movement of the body in a first direction from the position toward a first stop is to cause the trigger to actuate a switch via a magnetic field, and movement of the body in a second direction from the position toward a second stop is to cause the trigger to actuate the switch via the magnetic field.
2. The apparatus of claim 1, wherein movement of the body is to cause relative movement between the first magnet and the second magnet and relative movement between the trigger and the switch.
3. The apparatus of claim 1, wherein the body comprises a lever and a cam.
4. The apparatus of claim 3, wherein the first magnet and the trigger are operatively coupled to the cam via a follower.
5. The apparatus of claim 1, wherein the body is elongated and the second magnet is disposed along a length of the body.
6. The apparatus of claim 5, wherein the trigger is disposed along the length of the body.
7. The apparatus of claim 1, wherein the mount partitions the body from the switch.
8. The apparatus of claim 1, wherein the switch includes a proximity sensor.
9. An apparatus, comprising:
 - a mount; and
 - a switch actuator assembly coupled to the mount, the switch actuator assembly including a body, a trigger, and a first magnet oriented to be attracted to a second magnet to urge the body toward a position, wherein movement of the body in a first direction away from the position is to cause relative movement between the first magnet and the second magnet and relative movement between the trigger and a switch, and movement of the body in a second direction away from the position is to cause relative movement between the first magnet and the second magnet and relative movement between the trigger and the switch.
10. The apparatus of claim 9, wherein movement of the body away from the position is to actuate the switch without the trigger contacting the switch, and wherein the first magnet urges the body toward the position.
11. The apparatus of claim 9, wherein the body comprises a lever and a cam.
12. The apparatus of claim 11, wherein the trigger is movable with the body via a follower adjacent the cam.
13. The apparatus of claim 12, wherein the first magnet is coupled to the follower to operatively couple the follower to the cam.
14. The apparatus of claim 9, wherein the body is elongated and the second magnet is disposed along a length of the body.
15. The apparatus of claim 14, wherein the trigger is disposed along the length of the body.
16. The apparatus of claim 9, wherein the mount partitions the body from the switch.
17. The apparatus of claim 9, wherein the switch includes a proximity sensor.

18. An apparatus, comprising:

means for actuating movably coupled to means for mounting the means for actuating, the means for mounting including first means for magnetically urging the means for actuating, the means for actuating including second means for magnetically urging the means for actuating; and

means for magnetically actuating a switch movable with the means for actuating, wherein the first means for magnetically urging and the second means for magnetically urging urge the means for actuating toward a position, and wherein movement of the means for actuating in a first direction from the position toward a first stop is to cause the means for magnetically actuating the switch to actuate the switch via a magnetic field, and movement of the means for actuating in a second direction from the position toward a second stop is to cause the means for magnetically actuating the switch to actuate the switch via the magnetic field.

19. The apparatus of claim 1, wherein the body comprises a lever.

20. The apparatus of claim 9, wherein the body is to rotate away from the position.

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